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Rotational diffusion in polymer nanocomposites as probed by anisotropic particles[1]

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Metal nanoparticles strongly absorb specific wavelengths of light with no (or only a very weak) radiative relaxation by which to release this energy. As a result, the absorbed energy is efficiently converted to local heat (a photothermal effect). With an effective cross-section of up to 10 times its physical size, each particle acts as a "super-sized" absorber even when embedded within a transparent material environment such as a polymer, resulting in dramatic heating originating at the particles. Thus, with spatially-uniform illumination, one can metaphorically reach inside a polymer nanocomposite and apply heat to pre-selected subsets (e.g., causing them to dramatically change properties due to actuation, cross-linking, crystallization, or chemical reaction) without heating the sample surface or strongly affecting the remainder of the material. By utilizing optically-accessible additives including the particles themselves, the thermal gradient from the particle outward can be experimentally determined. In particular, rotational diffusion of anisotropic particles can be used to measure the temperature at the nanoparticle, which is the warmest point in a polymeric film or nanofiber under photothermal heating. Conversely, the same technique can be utilized to measure polymer dynamics in nanocomposites in the immediate vicinity of the particle.

[1] S. Maity et al., *Polymer* **52**, 1674 (2011).
[2] S. Maity et al., *Adv. Funct. Mater* **22**, 5259 (2012).
[3] S. Maity et al., *Part. & Part. Sys. Char* **30**, 193 (2013).

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